In Situ Alkaline Hydrolysis (ISAH) of Insecticides - A large-scale Demonstration Project

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In Situ Alkaline Hydrolysis (ISAH) of Insecticides—a Large-Scale Demonstration Project

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The site

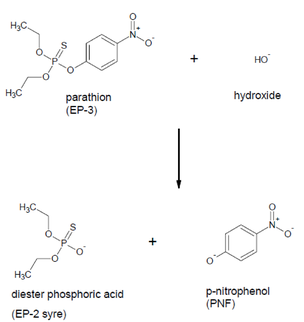
- "Groyne 42" is old chemical dumpsite, five acres in size, located on the beach on the west coast of Denmark
- The site contains >100 tons of acute toxic insecticides; ethyl-parathion, methyl-parathion, malathion and ethyl-sulfotep. Dumped by a chemical factory in the 1950'ies and 1960'ies.
- The pesticides are located 3-8 meters below soil surface (saturated zone)

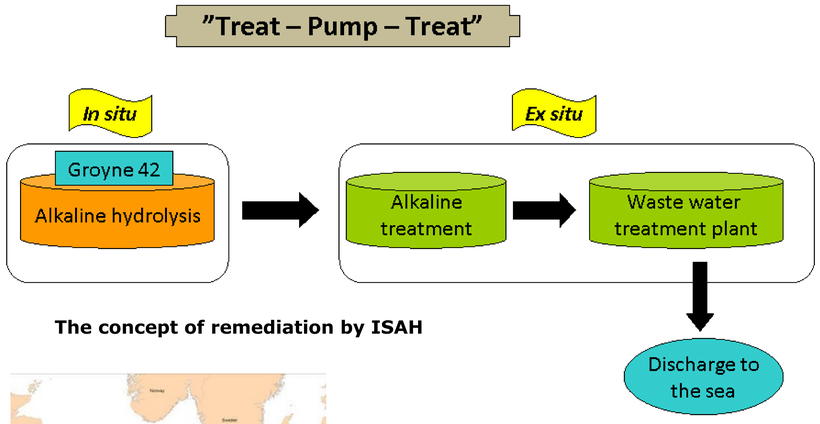
The experiment

- The method *in situ* alkaline hydrolysis (ISAH) is tested
- 3 test cells (each 100 m^2) are constructed in the "hot spot" using steel sheet piles to provide hydraulic control
- The test cells are drained and a dilute NaOH solution (50 m^3, pH 13) is added via infiltration wells
- Alkaline hydrolysis will degrade the pesticides into water-soluble hydrolysis products that can be removed by "pump and treat"
- Water and soil samples are analysed to document the efficiency of hydrolysis
- 3 methods to enhance the contact between NaOH and pesticides in the saturated zone were tested (acoustic vibration, recirculation and surfactant flushing)

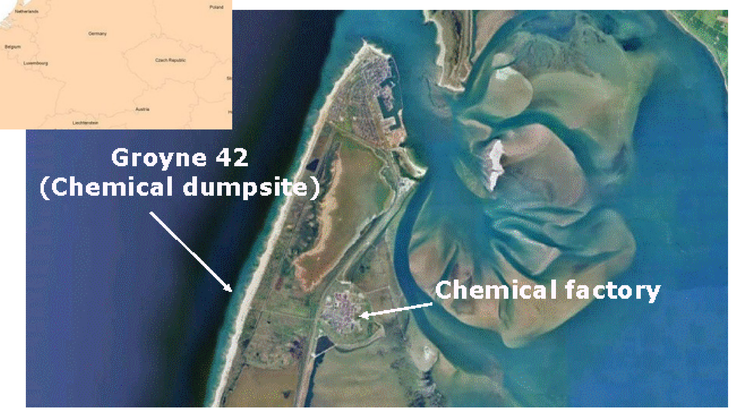
In Situ alkaline hydrolysis (ISAH)

- Alkaline hydrolysis of organophosphorous pesticides (e.g. ethyl-parathion) is a nucleophilic substitution reaction
- A strong nucleophile (hydroxide ion) attacks electrophile and displaces a leaving (functional) group
- Parathion has very low water-solubility
- The hydrolysis products have very high water-solubility





The concept of remediation by ISAH



Objectives of the experiments

- To document the efficiency of the ISAH
- To test the effect of "contact enhancement" technologies (acoustic vibration, recirculation and surfactant flushing) on the of rate alkaline hydrolysis

Results

Efficiency of ISAH (2 NaOH treatments, 2,5 years)

- Ethyl-parathion: 20-60% removed from soil
- Methyl-parathion: >90% removed from soil
- Malathion: >90% removed from soil
- Ethyl-Sulfotep: >90% removed from soil

Effect of "contact enhancement" methods on ISAH:

- Recirculation: No significant effect on the rate of alkaline hydrolysis. But had a positive effect on the distribution of NaOH
- Surfactant (Ecosurf EH9): No significant effect on the rate of alkaline hydrolysis. Greatly increased the dissolution of the pesticides
- Acoustic vibration: No significant effect on the rate of alkaline hydrolysis

Conclusion

- *ISAH* is an effective remediation method for certain organophosphorous pesticides
- The contact enhancement methods did not significantly increase the rate of hydrolysis, but flushing with the surfactant, Ecosurf EH9, increased the dissolution of the pesticides

For more detailed information visit www.NorthPestClean.dk

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NorthPestClean Pesticide Remediation

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